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PROCEEDINGS OF THE
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SERIES A. GENERAL ENTOMOLOGY.

VOLUME 12. 1937.

REARING TSETSE FLIES IN CAPTIVITY

By HELEN MELLANBY (Avebury Student), and KENNETH MELLANBY, F.R.E.S. (Wandsworth Scholar).

(*London School of Hygiene and Tropical Medicine.*)

THE life-history of the tsetse fly has been well known for some years, but in order to make the experiments detailed below more easily understood it will be described briefly. The female matures one ovum at a time, and this ovum hatches in the uterus. The whole larval period is inter-uterine, nourishment being provided by special glands. The female deposits the fully developed larva (which is then heavier than its mother) and pupation occurs in a few hours. At a mean temperature of 24° C. (75° F.) larvae are produced at 10–11 day intervals in most species, and the pupal period is about 30 days. Both males and females feed exclusively on vertebrate blood, but amphibians, reptiles and birds are attacked as well as mammals.

Many workers have tried to breed tsetse flies in captivity, but none has been successful enough to produce a supply sufficient for, say, trypanosomiasis investigations. Roubaud (1917) maintained a small stock of *G. morsitans* in Paris for three years, but only by taking an immense amount of trouble, and the culture died out in the end. We know of no other case in which the heavy mortality and slow rate of breeding (the two main difficulties which all workers have experienced) have not caused the culture to diminish in numbers and die out quite soon unless replenished with wild flies.

Many species of blood-sucking insects (fleas, mosquitoes) can be reared by keeping them in a cage with some suitable live animal host, and the insects have then fed whenever they have wished. This method has been tried by many workers with tsetse flies, and has always proved unsuccessful. Our experiments, using fowls and guinea pigs, appear to be typical. Batches of tsetse flies were put into cages of several different sizes which contained also the animal upon which it was hoped they would feed. In every case the insects all died in quite a few days, for very few ever fed. Even when the host animal was confined in one part of the cage which was brightly lit, and into which the flies were attracted because of their positive phototropism, they seemed unable to find the source of food. The smell of the animal seemed to permeate the whole structure of the cage, and to stimulate the flies to try and probe at any point of its surface equally with that of the animal itself, and those which did find the animal did so merely by chance.

The more tedious method in which batches of flies (or single flies in tubes) are put into direct contact with some host animal appears to be the only one by which any number of these insects can be kept alive. It is not sufficient, however, merely to give them an opportunity of feeding for say 15 minutes every day, although in nature flies feed probably only once every 4 or more days, and the process of feeding itself takes under 2 minutes. In captivity flies which are definitely "physiologically hungry" and containing less reserve materials than individuals which in the wild state come to man in order to take blood, often refuse food for some considerable time. However, if such flies are "coaxed," and put repeatedly into contact with their food they can usually be persuaded to feed. By this very laborious method it is possible to reduce deaths practically to nil during the first three months (at least) of the flies' lives, provided that they have not been damaged during the pupal stage.

In experiments in which batches of flies were exposed to various conditions of temperature and humidity, it was found least difficult to keep the flies alive at a constant temperature of 24° C. and in fairly moist air (relative humidity approximately 80 per cent.). At low humidities at the same temperature the flies survived equally well only if great care was taken with feeding, to prevent their dying from desiccation. Though the increased evaporation of water from the bodies of the insects upset their dry-matter : water ratio during starvation, the excess of water in each blood-meal was sufficient to restore their water-balance. The humidity did not affect breeding.

Temperatures above 30° C. prevent breeding by causing abnormal ovarian and embryonic development (for further details on this point see H. Mellanby, 1937). Below 20° C. (68° F.) most tsetse flies are inactive, and their metabolic processes are slowed down. If they are warmed they may feed quite well, but breeding, etc., is very slow.

Flies have been kept in different types of containers. Celluloid cylinders with gauze ends (described in detail by Buxton and Mellanby, 1934) were found convenient for keeping batches of 15 to 20 flies. To obtain the best results flies which did not feed when the whole batch was put in contact with a suitable host, and which looked as though they required a meal, were removed individually and coaxed (perhaps for a long time) until they did feed. The best survival was obtained by keeping flies separately in $2 \times 1\frac{1}{2}$ inch tubes with gauze tops, and containing a piece of blotting-paper to absorb the copious excrement. This method has the advantage that flies with few food reserves are not overlooked, but feeding is very tedious.

When a number of females are kept together with a very few males, many of the females may remain virgin indefinitely. The females are most attractive between about 5 and 8 days old, and it is necessary to have a great excess of males to females when the females are at that age to get anything like 100 per cent. fertilisation. The males are potent at any age after 5 days, but they seldom try to copulate with females which, though virgin, are over 10 days old. Copulation in the tsetse lasts *at least* half an hour, and fertilisation has not occurred when pairs of flies separate after a few minutes. It is possible to be sure that females have definitely been fertilised by introducing some individuals 5–8 days old into a cage full of active males. It is possible to remove the pairs without disturbing copulation, and any which remain connected for an hour are certain to be fertilised. An experiment described below proves that one fertilisation suffices for life.

In captivity eggs or tiny larvae are frequently aborted, and most other larvae are undersized. This is because it is impossible to persuade the females to take sufficient blood at the correct stage of early pregnancy. We found that when, by chance, a pregnant female fed really well, it produced a full-sized larva. The usual somewhat undersized larvae are not really "abortions," for they are produced in exactly the same time as full-sized ones, the period of gestation being always the same at any particular temperature. Once a female tsetse fly has been fertilised it produces larvae very regularly, unless gross undernutrition (which it is very difficult to prevent in captivity) causes early abortion. Eggs and tiny larvae when aborted are difficult to find, and so the flies which produce them may be thought to be sterile.

Adults which emerge from small "laboratory" pupae are themselves undersized, but are still fertile. We bred 4 generations of *G. palpalis* in London, and at the end of the experiment the population was slowly increasing. The small flies appear particularly prone to abortion, perhaps because they can accumulate less reserves.

One particular experiment bears out most of the points set out above. Six individual female *G. palpalis*, all known to be fertilised, were carried about by us during the summer. They were subjected to the ordinary climatic conditions of various parts of the British Isles, including the Outer Hebrides! They were given abundant opportunities of feeding. Sometimes they were quite dormant due to cold until warmed by the human body for feeding. The low temperatures interfered with nutrition, so that many abortions occurred, but all of the flies produced pupae at intervals up to the end of the experiment. The average survival of the flies was 170 days, the maximum being 215 days. Dissections showed that death occurred with the alimentary canal full of improperly digested blood; this was probably a symptom of "old age," for most wild flies die much younger (Lloyd, 1936). In all these females the spermathecae were still full of motile sperm when the flies died, though they had all been fertilised once only during the first week of their adult lives. There was no possible chance of re-fertilisation, as we had no stock of males during most of the period of the experiment!

Most of our work was done using *G. palpalis*, but a few observations on *G. morsitans* and *G. swynnertoni* show that these species behave in a similar manner.

SUMMARY.

The usual cause of death of tsetse flies in captivity is starvation. If flies are given individual attention and "coaxed" into feeding when they contain few reserves, mortality can be greatly reduced.

Provided that females have been fertilised (many workers have assumed females which are still virgin have been fertilised) successful pupal production depends on careful feeding. It is not always possible to persuade pregnant females to take sufficient blood to provide material to produce full-sized larvae.

The longest period which a female fly survived in captivity in these experiments was 215 days. 208 days had elapsed since it was fertilised, but at death its spermathecae still contained motile spermatozoa.

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ON A NATURAL HYBRID IN THE GENUS *EREBIA* (LEPIDOPTERA)

By B. C. S. Warren, F.R.E.S.

With Plates 1–2.

In 1914 Schwingenschuss described two remarkable specimens of an *Erebia* as *Erebia epiphron* ab. *intermedia* (*Verh. zool.-bot. Ges. Wien*, **64** : 171). He had captured them on the Schafberg at Pontresina in the Grisons. In his description Schwingenschuss remarked that on account of the markings of the underside of the hind-wings in both specimens he could not help wondering if they were a cross between " *epiphron* (Kn.) var. *cassiope* F. und *flavofasciata* (Heyne) var. *thiemei* Btl."

At the time of writing my recent work on the genus (*Monograph of the Genus Erebia*, 1936), not having seen these specimens I retained *intermedia* as an aberration in accordance with Schwingenschuss' description. I must also admit that I am always sceptical of reputed hybrids, which so often are assumed to be hybrids merely because their captor has not been able to identify them in a satisfactory manner.

Some months ago I received three male specimens of an *Erebia* taken by Mr. C. W. Wyatt on the Schafberg (the same locality from which Schwingenschuss' two males came), and an examination of these three specimens leaves no room to doubt that they are true, natural hybrids, and as their superficial markings agree exactly with description given by Schwingenschuss, it seems certain that they are the same insect which he named *intermedia*. This hybrid has therefore occurred, naturally, a second time in this locality, nineteen years separating the two known occurrences. Wyatt had actually taken six of these insects in all, in 1935, all males; the remaining three which I have not seen are exactly similar, he tells me, to the three he sent.

The appearance of these three specimens (pl. 1, figs. 1 and 2) at once suggested that they could be no ordinary aberrations of the very dark, indistinctly marked f. *nelamus* of *E. epiphron* ssp. *aetherius*, which is the prevalent form of this species on the Schafberg and in the neighbouring districts at Pontresina. One specimen (the upper specimen in pl. 1, figs. 1 and 2) was indeed suggestive of f. *nelamus* on the upperside, but on the underside it shows the spots and traces of the markings peculiar to *E. flavofasciata*, being very like the f. *warreni* of the latter. The other two specimens are more similar to *E. flavofasciata* on the upperside as well as the under, though both the size of the black spots and the width and extent of the red markings on the upperside are more pronounced than is normal in any form of the latter. Still anyone who compares the figures with specimens of *E. flavofasciata* and Swiss *E. epiphron* ssp. *aetherius* cannot fail to note the general resemblance of these specimens to *E. flavofasciata* in the markings of the underside, while the colour of these underside markings and the general markings of the upperside are more those of *E. epiphron aetherius*. Of course one must remember that in any Swiss *E. epiphron aetherius*, black spots and rusty rings on the underside of the hind-wings are extremely rare in the males, though of frequent occurrence in other races of the species.

As it was of course impossible to come to any certain determination of the nature of these remarkable specimens from an examination of their superficial appearance alone, I was very glad to avail myself of the generous offer of their captor to allow me to dissect them.

The first impression conveyed by the three mounts of the genitalia (pl. 1, figs. 4, 5, 6) was that they were some form of *E. epiphron* f. *nelamus*; the forma-

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tion of the clasps and their spine systems appearing nearly typical of the latter. On further examination, however, the formation of the dorsal structures was seen not to be in agreement, and in fact decidedly suggestive of the formation in *E. flavofasciata.*

On critical examination it became apparent that four characters peculiar to *E. epiphron*, though present, were very remarkably modified in these three specimens, and that this modification tended in the direction of the homologous structures in *E. flavofasciata.* The four characters are: the termination of the uncus; the brachia; the termination of the clasps; and the spine system of the dorsal ridge of the clasps. Once these points had been observed, the possibility that these specimens were aberrations of *E. epiphron* became much more doubtful. There remained one other possibility, namely, that the structural modifications were some local, racial production, normal to the f. *nelamus* on the Schafberg. This possibility was strengthened by the fact that the general formation of structure in a specimen from the Tschierva Glacier which I had already figured (*loc. cit.* pl. 28, fig. 274) showed some variation from the typical *E. epiphron* form, an occurrence which frequently happens in different subspecies of an Erebiid species. Unfortunately the only specimens of the f. *nelamus* from that district which I possessed were all from the Piz Tschierva; however, Mr. Wyatt sent me two males he had taken on the Schafberg flying with the six hybrids. On dissection it was found that both were absolutely normal and typical of *E. epiphron* in every detail (pl. 1, fig. 3). The f. *nelamus* therefore does not develop a racial structural variability on the Schafberg, for my work on subspecific structural variation (*loc. cit.* in connection with anatomical details of many species) has shown that when such variation occurs the affected characters vary in almost every individual, and the occurrence of two absolutely typical individuals would be most unusual.

To consider the structural modification of the three hybrid specimens in detail:—

(1) The uncus.—In *E. flavofasciata* the uncus is long, slender and terminates in a very sharp point directed downwards (pl. 2, fig. 6); in *E. epiphron* it is shorter and slightly stouter in proportion to its length, terminating bluntly rounded off (pl. 2, fig. 5); in the hybrid specimens the uncus is of the same build as in *E. flavofasciata* and terminates in a point directed downwards, but it is slightly shorter and the terminal point shorter and blunter (pl. 2, fig. 7).

(2) The brachia.—In *E. flavofasciata* these lateral processes are long and slender and very slightly curved (pl. 2, fig. 6); in *E. epiphron* they are shorter, both actually and relatively in proportion to the length of the uncus, and are usually (though not always) more markedly curved (pl. 2, fig. 5); in the hybrid they follow the lines of *E. flavofasciata*, though slightly heavier and more curved (pl. 2, fig. 7).

(3) The termination of the clasp.—In *E. flavofasciata* the clasp is rounded off at the end and terminates free of spines (pl. 2, fig. 2); in *E. epiphron* the clasp terminates in a solitary, strong spine, which has no counterpart in any other species of the *epiphron* group (pl. 2, fig. 1); in the hybrid the clasp termination is similar to that in *E. epiphron*, but the solitary terminal spine is blunted off and shorter (pl. 2, figs. 3 and 4).

(4) The spine system.—In *E. flavofasciata* there is a continuous series of intermingled coarser and finer spines on the dorsal edge of the clasp, which extend unaltered over nearly the whole length (pl. 2, fig. 2); in *E. epiphron*, though somewhat similar, the coarser spines at the base give place to much finer and more closely set spines on the head (pl. 2, fig. 1), this change in the

size of the spines can even be seen in the less magnified photograph (pl. 1, fig. 3). In the hybrid the spine system may be said to be that of *E. epiphron*, but modified to some extent, the fine spines being coarser and less dense, and in the gaps between them indentations appear in the ridge of the clasp, such as are never found in *E. epiphron* though often in *E. flavofasciata* (pl. 2, figs. 3 and 4).

(These notes might be compared with the descriptions of the genitalia of these species which I have given, *loc. cit.* : 101, 102, *E. epiphron* ; : 98, *E. flavofasciata*, and also the figures, pl. 28, which are all done to the same scale as those accompanying this paper.)

On the development of the four characters just described it would not be possible to refer these three specimens to either *E. epiphron* or *E. flavofasciata* alone, for they show a most remarkable amalgamation of the characters of both.

Having established the structural peculiarities of these specimens there remained no question as to their hybrid origin, especially as the characters affected are among those which I have shown (*loc. cit.* : 26–28) to be some of the most reliable where the question of specific differentiation is concerned. It seemed, however, that any further data would be of interest, so in spite of the chance of damage to such rare specimens I decided to examine the scales, for in my previous work I have already shown that the characters of the androconial scales invariably corroborate the facts derived from the developments of the genitalia.

It must be recalled that the androconia in *E. flavofasciata* are extremely characteristic, being in what I have called the palaeomorphic stage of development (*loc. cit.* : 98, pl. 17, figs. 141–144) and entirely dissimilar to the androconia of any other species. On the other hand, *E. epiphron* is without these scales.

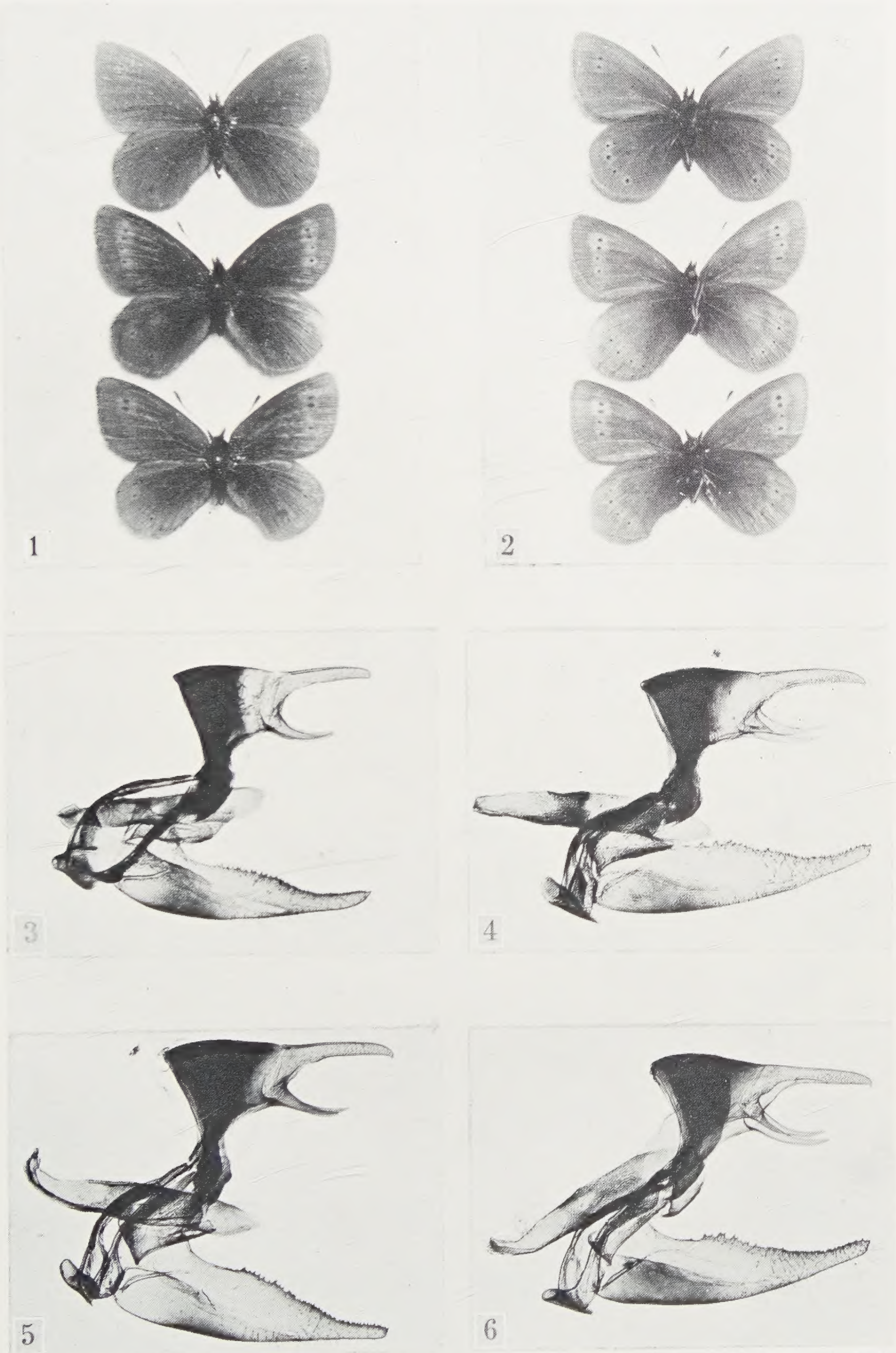
Altogether I made some fourteen preparations of the scales, finally completing the mounting of six : with the following result.

(1) Androconial scales were present, though few in numbers compared with the normal abundance in *E. flavofasciata*.

(2) The number present seemed to differ in each specimen.

(3) The scales were typical (unmodified) of *E. flavofasciata*, being for the greater part of the palaeomorphic form, a few examples of the eomorphic also occurring as well as transitional examples such as also exist in *E. flavofasciata*. One of the transitional examples is shown on pl. 2, fig. 8.

There could remain no other possibility but that these three specimens which showed such striking structural and superficial connection with *E. epiphron* and yet possessed this scale peculiar to *E. flavofasciata*, must be true natural hybrids. But this was not all. The data further demonstrate that the specimens must have been the offspring of a cross between *E. flavofasciata* f. *thiemei* ♂ × *E. epiphron* ssp. *aetherius* f. *nelamus* ♀. I have already mentioned that androconial scales do not exist in *E. epiphron*; had the male been of the latter the production of these scales would have been impossible in the hybrid. For supposing that the production of androconial scales is dependent on the two sexes, involving the presence of some complementary female factor, the presence of this factor in the f. *thiemei* female would not suffice to produce scales of the true *E. flavofasciata* type when the male *E. epiphron* could contribute nothing towards their development. In the case of the genitalia (present in all species), the female could be supposed to supply the complementary factor necessary to their development in another species, though in such a case the normal formations typical of the species to which the male parent belonged could not be expected to be reproduced in unaltered form, owing to the substitution of an



ENGRAVED BY STAR ILLUSTRATION, LONDON.

A natural Erebiid hybrid.

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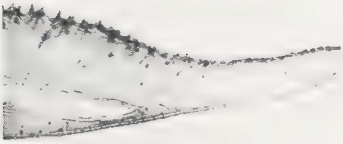

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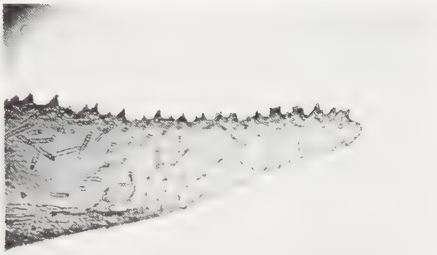

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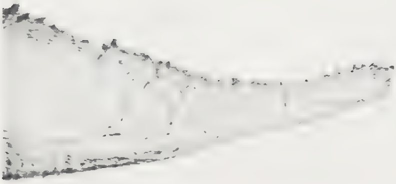

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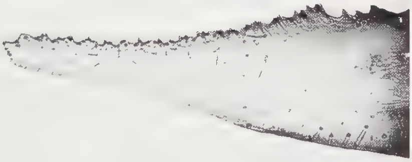

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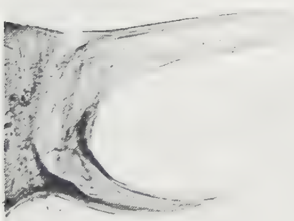

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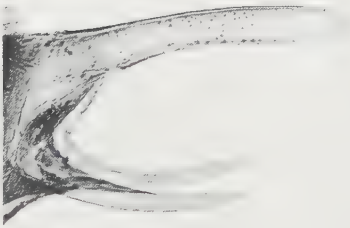

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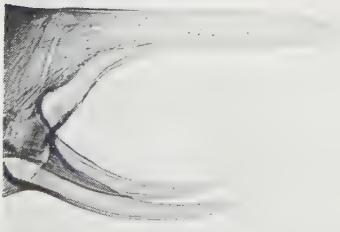

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Genitalia of *Erebia spp.*

abnormal female element. In the present case this is precisely what occurred; the genitalia exhibiting a combination of the characters of both species.

In the scales, however, there is no modification of type, their development has been unaffected by the unnatural female parent. The male parent in the cross must therefore have been *E. flavofasciata.* A further confirmation of this is to be found in the markings on the upperside of these specimens. The extent and clearness of the mahogany bands, in two of the three specimens, surpasses that which is normal to either sex in *E. flavofasciata* or the male in *E. epiphron* f. *nelamus.* Such characters can only have been derived from a female of the latter.

It does not seem necessary to discuss the possibility of these hybrids merely being aberrations of *E. flavofasciata* f. *thiemei.* The facts already given show this to be impossible. The very limited number of androconial scales present also proves this. The number of these scales can vary between the subspecies of one species, but in my experience there is never any noticeable variation in numbers within the limits of one subspecies.

Finally, some interesting points bearing on the question of heredity are demonstrated by the facts recorded.

The great limitation of markings which is normal in the very dark males of *E. epiphron* f. *nelamus* must be a character directly inherited from the male parent, since the complementary female factor apparently operates in exact opposition, *i.e.* tends to produce brightly marked males. The very rare occasions in which a more clearly-marked male of the f. *nelamus* occurs, must result either from an excess of the female factor or the latent presence of characters of other northern races of *E. epiphron* in some males.

Inheritance in the case of the scales appears dependent on the male parent alone, their development being equally perfect when the male is mated with a female of a species in which androconial scales do not exist, as with a female of its own species.

The question of how, and to what extent, the ordinary scales of the hybrids were affected by the cross, will necessitate a great amount of further study before any exact estimation of the matter can be arrived at.

In conclusion I must express my great indebtedness to Mr. Wyatt, who, though he suspected the nature of his specimens and their consequent rarity, did not hesitate to permit me to dissect them.

Explanation of Plates.

Plate 1.

Fig. 1. *Erebia* hybrid *intermedia* Schwnshs. Upperside, natural size.
2. *Erebia* hybrid *intermedia* Schwnshs. Underside, natural size.
3. Male armature, *Erebia epiphron* ssp. *aetherius* f. *nelamus* × 18. Schafberg, Pontresina.

Figs. 4–6. Male armatures, *Erebia* hybrid *intermedia* × 18. Schafberg, Pontresina.

Plate 2.

Fig. 1. *Erebia epiphron* ssp. *aetherius* f. *nelamus*, end of clasp × 48.
2. *Erebia flavofasciata* f. *thiemei*, end of clasp × 48.

Figs. 3 & 4. *Erebia* hybrid *intermedia*, end of clasp × 48.

Fig. 5. *Erebia epiphron* ssp. *aetherius* f. *nelamus*, uncus and brachia × 48.
6. *Erebia flavofasciata* f. *thiemei*, uncus and brachia × 48.
7. *Erebia* hybrid *intermedia*, uncus and brachia × 48.
8. *Erebia* hybrid *intermedia*, transitional eomorphic-palaeomorphic androconial scale × 200. Photos. B. C. S. Warren.

A GRASSHOPPER NEW TO BRITAIN

By Dr. K. G. Blair, F.R.E.S.

Specimens of *Conocephalus fuscus* Fab. from Chale, Isle of Wight, September 1931, provide an addition to the list of British grasshoppers. A macropterous ♀ of *C. dorsalis* Latr. taken last year by Mr. P. Freeman at Waxham, Norfolk, was also exhibited.

Dr. Malcolm Burr said that on the Continent *C. fuscus* was a common and widely distributed species that he had long expected would be found in Britain, whereas *C. dorsalis* was everywhere local and only found in north-western Europe. The macropterous form of the latter (var. *burri* Ebner, 1910) was unknown except for the single record by W. H. Harwood from Clacton-on-Sea in 1899 (1900, *Ent. Rec.* **12** : 128, 129) until found by Dr. Ebner in Austria (*Mitth. naturh. Ver. Univ. Wien*, **1910** : 142).

Book Notice.

The Natural History of Wicken Fen, edited by Prof. J. Stanley Gardiner. 6 pts. Cambridge. Bowes and Bowes, 33*s*. 0*d*.

This unique work covering the natural history of a locality of special interest to entomologists was completed in 1932 by the issue of the last part. The six parts form a volume of 652 pages, consisting of 56 separate contributions on special branches, each by a specialist.

The Royal Entomological Society of London has a great interest in Wicken Fen, since of the large area now vested in the National Trust, the first few acres were presented to that body by Mr. J. C. Moberley in 1899, and large tracts were presented by Mr. A. E. Verrall and the Hon. N. C. Rothschild, past Presidents of the Society. In addition, the Society, through its Committee for the Protection of British Insects, is greatly interested in the management and has from time to time made recommendations on specific matters relating to the fen.

Complete lists of all orders of insects are included.

The editor is to be congratulated on having brought to a successful conclusion a work covering completely so wide a field.

A FLIGHT OF A BUTTERFLY THAT APPEARED TO BE *CATOPSILIA FLORELLA* FAB. IN THE STRAITS OF MESSINA

By Professor G. D. Hale Carpenter, F.R.E.S.

Mr. C. M. N. White, of Balliol College, Oxford, has kindly given me the following interesting notes.

" The following observation was made on a voyage from Marseilles to Peiraeus on s.s. *Cairo City*.

" On July 29th, 1936, while the ship was passing through the Straits of Messina a considerable number of butterflies was noticed flying from Italy to Sicily. None came on board, but they appeared about the size of a Large White but more sulphur, and I concluded that they might be Brimstones. I have since seen specimens of the Mediterranean form of Brimstone, and I believe they resembled very closely the female of it. They appeared much too large and pale for clouded yellows, and no orange was visible as in the male of the Brimstone of the Mediterranean.

" The day was fine and bright with a light wind blowing from the north-east; the observation was made at about 11.30 a.m."

The chief interest lies in the identification of the species, for none could be captured. Mr. White was shown a drawer full of *Gonepteryx cleopatra* (L.) and at once said that there were certainly no males of that species among the flight, all the butterflies were greenish. Subsequently when shown *florella* he stated that the species seen was more like that than any other of the species mentioned by Dr. Williams in the letter quoted below. I know Mr. White, personally, as an observant and critical field ornithologist, used to noting differences, and feel quite sure that his account of the appearance of the butterflies is reliable. It is therefore quite possible that the species was *florella*, and the observation is the first on its appearance in Europe. The distribution around the Mediterranean given by the *Lepidopterorum Catalogus* includes both east (Syria, Egypt) and west (Mauretania) ends of the southern coast, but I know of no record from the middle parts.

The observation was reported to Dr. C. B. Williams, who wrote :—

"*Rothamsted Experimental Station, Harpenden*, 17.x.36.

" This is only the third record that I have for this area. Previous records are—(1) May 18th and 21st, 1913. On Mt. Etna and Mt. Cicci : two flights seen by J. P. Barrett (*Proc. S. Lond. ent. nat. Hist. Soc.*, **1913-14** : 118–119) consisting of *Aporia crataegi* (L.), with a few *Pieris brassicae* (L.). All the *crataegi* captured were males of form *augusta* Tur. This is said by the inhabitants to be an annual occurrence. (2) 25th June, 1933. Large numbers of Pierids observed crossing the Straits of Messina from Italy to Sicily by Lieut.-Col. H. F. Stoneham, O.B.E. : a large species that, it was suggested, might have been *Aporia crataegi* (L.). (3) The present observation, the flight being as in No. 2. Have you any evidence that *Catopsilia florella* Fabr. has ever reached Europe ? I have never heard of it. In view of the apparent regularity of the movement I think it must be some common local species, either Brimstone (but I have no record of *Gonepteryx* migrating in Europe !) or *Pieris brassicae* (perhaps rather yellow on the underside) or *Aporia crataegi*."

Mr. White does not, however, think that *brassicae* with which he is familiar, or *crataegi*, correspond to what he saw.

A CAT CAPTURING AND EATING A LARGE CALIFORNIAN *PAPILIO*

By Sir EDWARD POULTON, F.R.E.S.

I HAVE great pleasure in communicating the following interesting and curious observation described in a letter, written 8th July 1936, from Los Angeles, by my friend Prof. F. C. S. Schiller, D.Sc. :—

" I cannot forbear to report to you an act of feline criminality which I witnessed a few days ago (July 3), knowing your interest in the attacks of birds on butterflies. I had been lunching with my wife at the Hollywood Hotel with Lady Adams, and after lunch went into the garden, where we were admiring a large yellow and black *Papilio* (I think *turnus*) on a flowering bush. Suddenly a mouse-grey cat rushed up behind us, jumped a couple of feet into the air (or more) caught the butterfly (no stalking !) and departed with its prey in its mouth. We saw it again later with only the ends of the wings protruding, so that it seems to have acquired both the habit and skill in catching and eating butterflies."

[Mr. C. L. Collenette has called my attention to J. A. Bucknill's note in the *Zoologist*, **1894** : 24, describing the capture of *Pyrameis atalanta* L., when resting on fallen fruit in Devonshire. The author " repeatedly saw a cat stalk and catch these ' Red Admirals ' in her paws, play with them like a mouse, and eventually chew them to a shapeless mass. I never saw her miss catching one. . . ." An editorial note on cats adds—" we have repeatedly seen one catch small moths . . . and devour them with apparent relish."—E.B.P., 23 Dec. 1936.]

CHEMICAL CHANGES IN THE FOOD-PLANT A CAUSE OF FAILURE IN REARING LARVAE

By V. G. L. VAN SOMEREN, C.M.Z.S., F.R.E.S.

[SIR EDWARD POULTON communicated the following extract from a letter which he had recently received from his friend in Nairobi.]

" *15th October*, 1936. Referring to that point about high death-rate in captive broods, it is of interest to note that when this took place there was an almost equal death-rate in wild larvae left on the trees—death not due to parasitism. In fact, not only in *dardanus* is this very noticeable but in other species, including *Charaxes etheocles* and *ethalion*. There is some change in the food-plants, and indeed at this time the trees shed their leaves or they wither up, and this corresponds with the advent of the dull, cold weather prior to the very dry season and an absolute dearth of insect life, most noticeable amongst Lepidoptera, of course. Another naturalist has been handling stuff this year and he has had the same experience as mine—in fact, where special attention has been paid to a particular brood (say *P. rex*), after a certain point the larvae will not develop further, and very few reach the pupal stage, while those that do reach it are dwarfed and the imagines equally so.

" I believe that this is one method of natural control by means of a change in the chemical composition of the foliage—retarding larval growth and even causing death. I lost all my fine *ethalion* and *etheocles* broods because the trees shed all their leaves and there was no food available—most disappointing."

THE COMMON EARWIG, *FORFICULA AURICULARIA* L., OBSERVED ON THE WING IN 1843 BY J. C. DALE

By Sir Edward Poulton, F.R.E.S.

Although a large body of convincing indirect evidence proves that the Common Earwig is capable of flight and although several naturalists have seen these insects on the wing—as recorded in our *Proceedings* (**5** : 41; **6** : 10, 93), I feel sure that the following statement, in one of J. C. Dale's manuscript notebooks in the Hope Dept. of Entomology at Oxford, will be read with interest. It was found by my friend Dr. B. M. Hobby.

" *Sept.* 4, 1843 :—Took *Forficula auricularia* flying by moon light, it looked like a small moth."

The observation was made, I have no doubt, at Glanville's Wootton on this and other dates when no locality is mentioned. " Wootton Wood " is recorded for 13th November, 1843, on the same page of the notebook.

CHRYSIS SHANGHAIENSIS SMITH, A PARASITE OF *PARASA LEPIDA* CR.

By D. G. Sevastopulo, F.R.E.S.

Instances of Chrysididae as parasites of Lepidoptera are sufficiently rare to be worth recording.

On the evening of the 20.vii.1936 and on the morning of the 21st I noticed a bright green Chrysid on the trunk of a small mango tree on which a large number of *P. lepida* larvae were spinning their cocoons. On the evening of the 21st I caught a specimen in the act of nibbling at one of the *lepida* cocoons, and on the morning of the 22nd I caught a second.

It seemed obvious that there was some connection between the wasp and the cocoons, so I kept them under observation and eventually noticed that a number of cocoons remained intact a week or more after the bulk of the moths had emerged. Later I noticed that some of these late cocoons had hatched but that the exit hole was very different from the neatly cut out lid made by *lepida*.

On 6.ix. I decided to open any intact cocoons and found, among a number that contained dead and mildew-covered *lepida* larvae and pupae, two containing Hymenopterous pupae in thin cocoons. Of these, one was almost completely pigmented and obviously the Chrysid, whilst in the other pigmentation had just commenced.

Mr. R. B. Benson, to whom I am indebted for the identification of my specimens, referred to a paper by Parker (1936, *J. agric. Res.*, **52** : 449-458), which deals with the life-history of this particular species of Chrysid and which describes it as a parasite of *Cnidocampa flavescens* Wlk., mention is made that it probably feeds on other moths belonging to the Limacodidae.

THE NUMBERS OF MALES AND FEMALES IN NATURAL POPULATIONS OF HEAD-LICE (*PEDICULUS* : ANOPLURA)

By P. A. Buxton, F.R.E.S.

(*Professor of Medical Entomology, University of London.*)

It will be remembered that a method has recently been described by which one can dissolve large samples of hair, leaving the lice, if any are present, so that they can be studied (Buxton, 1934). Making use of this method, investigations have been made on populations of head-lice from several parts of the world. The material here discussed is derived from a large collection of specimens of hair, each one of which was the complete crop of the head of an adult male prisoner in a certain tropical jail. The insects had the characteristics of head-lice (*P. humanus capitis*). The total number of crops of hair received from this jail was 240; of these 96 were without lice and 19 contained young insects only. One is left, therefore, with 125 samples in which adult lice were found. These samples are of particular interest because some of them contained such unusually large numbers of adult lice; in nine heads the number of adults exceeded 100, the highest being 774.* I have not observed such high counts from other parts of the world, and cannot say whether the phenomenon here described is of general occurrence.

It is already known that the proportion of the sexes in a single family of lice is often very far from equality; indeed, families which are unisexual or very nearly so have been observed (Hindle, 1919; Doncaster and Cannon, 1920). It is not, therefore, surprising that in a single natural population great inequality in the numbers of males and females is frequently found. But I am not at the moment concerned with that point, but rather with the sex ratio which may be observed when large numbers of natural populations are grouped according to their density. The 125 samples which are under consideration have been grouped according to the number of adult lice in each sample, and the results are shown in Table 1. The fifth column shows a consistent tendency for the number of males to increase, as the total number of adult lice in the head becomes greater. A similar phenomenon is found, as might be expected,

TABLE 1.

The heads of hair have been arranged in a frequency distribution, according to the number of adult lice (males and females) per head.

Adult lice per head.	No. of heads.	No. of males.	No. of females.	Males per female.	Contributions to χ^2 ♂.	♀.
1–2	49	20	46	43·5	7·8	10·0
3–10	32	85	101	84·2	3·6	4·6
11–25	22	166	198	83·8	7·2	9·2
26–100	13	307	310	99·0	4·5	5·7
101 and up.	9	1768	1179	150·0	7·9	10·0
Total .	125	2346	1834	127·917		

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* I find that the number of larvae per adult varies considerably, even when large numbers of crops of hair are examined: one may obtain approximately the total number of lice of all ages by multiplying these figures by 5.

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when the frequency distribution is made according to the number of females per head. The tabulation need not be published, but it showed that in the groups with females 2–5, 6–10 and 11–20 the males per female were 0·93, 0·94, and 0·98 respectively. But with females 21–50 (10 heads) and 51 and over (7 heads) the males per female were 1·24 and 1·41.

The consistency of increase in the proportion of males (whichever way the figures are tabulated) is a strong argument against the figures being due to chance, but the cautious reader is justified in demanding some test of the significance of the figures, having regard to the rather small number of heads in the last group in Table 1. Application of the test for goodness of fit to the actual numbers of males and females gives a value of 70·5 for χ^2, indicating that the figures could not reasonably be attributed to chance, the odds being more than one million to one against that explanation.

It appears then that one would be justified in stating that the difference in the sex ratio between a sparsely and densely infested head is a genuine biological phenomenon. It seems that there are only three possible explanations of it :—

(i) The increased proportion of males in the more densely infested heads might be due to an actual alteration in the sex of individuals. If this occurred, the change would presumably take place in the egg or early in larval life, and would be due in some way to the effect of crowding upon the parents or the newly emerged larvae. This appears to be improbable, for none of the workers who have reared these insects experimentally has observed any indication of such an effect. If there were a tendency for more males to be produced in those boxes in which the insects are most crowded, it would surely have been noticed, particularly by Hindle (1919), who was interested in the sex ratio of families. I have myself carried out experiments designed to test this very point, isolating pairs of lice, and rearing some of their eggs in groups of 40–50 per box, others in groups of 8–10 per box, but failing to obtain any significant alteration in the sex ratio of the lice reared. The conclusion is that though one cannot exclude the possibility that crowding has an effect on the sex of lice, it is improbable that it has any such effect.

(ii) It is possible that when the insects are very crowded it might be difficult for some of them to obtain sufficient food, and that this might produce a differential death-rate tending to kill those larvae which were destined to become females. This explanation also seems unlikely, for it is difficult to believe that a blood-sucking insect on the skin of its host could ever lack sufficient food.

(iii) It is possible that when the population passes a certain density, conditions become unfavourable to the females, and that this shortens the mean life of the females more than that of the males. It would perhaps be difficult or impossible to observe this in nature, but it is not difficult to plan an experiment which appears to explain some of the facts shown in Table 1. A strain of body-lice (*Pediculus humanus corporis*) was bred in flat pill-boxes, 1 inch in diameter, in the bottom of which was a hole $\frac{1}{2}$ inch in diameter, covered with gauze. The boxes were carried against the skin continually during the day, but taken off at night. Large larvae of the insect were isolated, and when they attained maturity pairs were made up. From 18 such pairs the following figures were obtained :—

Length of life of ♀, mean 38·3 days, standard deviation 12·25, extremes 53 and 14.
Number of eggs per ♀, mean 137·8, standard deviation 67·42, extremes 204 and 17.

One may say, therefore, that the females lived over one month, laying nearly 4 eggs per day, though the degree of inconsistency is very high. When, however, a single newly emerged female was put with several males of about the same age, she invariably died in a few days, having laid few or no eggs. Details of five such experiments are as follows :—

18 ♂♂, 1 ♀ Female lived 11 days, laid 10 eggs.
15 ♂♂, 1 ♀ ,, ,, 7 ,, ,, 0 ,,
10 ♂♂, 1 ♀ ,, ,, 7 ,, ,, 9 ,,
6 ♂♂, 1 ♀ ,, ,, 11 ,, ,, 5 ,,
6 ♂♂, 1 ♀ ,, ,, 1 ,, ,, 0 ,,

It is clear that in these experiments female lice (or at least young females) lay few eggs and die in a few days if they are confined with an excess of males, though the cause of death is obscure. One may surely apply these observations, made on insects in small boxes, to what happens in a state of nature : it may be supposed that when the density of a natural population of lice passes a certain limit, the average female meets a male, with which she presumably pairs, at intervals of time which are unduly short. This has an unfavourable effect upon the females, so that they die sooner than they otherwise would, and so become more rare in the population as a whole.

Taking the hypothetical case of an infestation which starts with one pair of lice colonising the head of a complacent host, the population would at first increase by compound interest. At a certain density (apparently when the number of adult females was a little past 20) conditions would become unfavourable for the females, which would lay few eggs and tend to die. The population would then drop to a level at which this unfavourable effect ceased to exert any effect ; after which the population would increase and decrease indefinitely.

It is impossible to leave the subject without calling attention to a most interesting analogy. The effect of male lice upon females under certain conditions of overcrowding resembles closely that which predators are believed to exercise upon populations of prey. In each case the unfavourable factor is one the effect of which depends upon the density of the insects. In each case also there is reason to think that the population will oscillate about a mean, without ever reaching a position of stable equilibrium. It would be inappropriate to go deeply into the general question, but it will be remembered that the theoretical work of Volterra and also of Lotka give reason for supposing that such oscillations would take place, and that Gause * has recently demonstrated such oscillation experimentally, using *Paramecium* as predator, and living yeast cells as prey.

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* Gause, F. G., 1935, Experimental demonstration of Volterra's periodic oscillations in the numbers of animals. *J. exper. Biol.*, **12** : 44–48.

NOTES ON THE STATUS OF FLIES OF THE FAMILY SPHAEROCERIDAE (BORBORIDAE) IN THE ECONOMY OF CULTIVATED MUSHROOMS

By M. D. Austin, F.R.E.S.

(Dept. Economic Entomology, South-Eastern Agricultural College, Wye.)

In the course of investigations on the fauna associated with cultivated mushrooms certain insects, notably flies of the genus *Sciara*, have been found to be major pests, whilst in the case of others it has not been always possible to state with certainty their actual status in this connection. Of these, members of the family Sphaeroceridae (Borboridae) have been found associated with mushroom beds and more frequently with stable manure before its ultimate use as mushroom compost. For instance, Theobald (1928) records their presence in mushroom houses, and Austin (1933) mentions one species, *Limosina* (*Leptocera*) *ferruginata* Stenh., as being taken in large numbers from a heap of composted manure and also from an established bed, but in neither case was damage to mushrooms attributed to the larvae of these flies.

Later Austin (1934), writing of *L. ferruginata*, records " . . . its position as a factor in the economy of mushroom beds is uncertain. At present it can only be stated that this fly has not yet been reared from larvae-infested mushrooms and manure during this investigation." In view of the general uncertainty as to the status of this fly and related species, it was decided in 1933 to commence an examination of compost prior to its use for mushroom culture in an attempt to collect data relative to the species and numbers of insects present in this material and to assess their possible influence in the economy of the ultimate mushroom beds. This investigation yielded interesting data on the occurrence of certain species of Sphaerocerids, but at no time during the period covered by the investigation were any of the many species involved recorded as pests (Austin and Jary, 1934, 1935). The species recorded at that time as being reared from larvae in manure were as follows: *Sphaerocera vaporariorum* Hal., *S. subsultans* L., *S. pusilla* Mg., *Leptocera* (*Limosina*) *ferruginata* Stenh., *L. heteroneura* Hal., *L. puerula* Rdi., *L. luteilabris* Rdi., *L. hirtula* Rdi., *L. mirabilis* Collin and *L. crassimana* Hal. This occurrence of the larvae of a relatively large number of species of Sphaerocerids within manure, ultimately to be used for mushroom culture, was followed, in 1936, by an interesting discovery. During May, mushrooms heavily infested with dipterous larvae were collected from a mushroom bed at Wye and isolated in a section of an insectary. The material was primarily intended to further studies on the family Phoridae, there being many larvae of flies of this family present. However, it was interesting to observe that the first batch of adults to emerge (June 21) were Sphaerocerids; later Dr. O. W. Richards identified the species concerned as *Leptocera heteroneura* Hal., a species which, it will be noted, was repeatedly obtained during the compost fauna study. At this point it is worthy of note that Staniland (1936) recorded Borborids (Sphaerocerids) as damaging mushrooms at Newton Abbot. In the case referred to above I was not prepared to state that the larvae were the primary cause of damage owing to their association with Phorid larvae, but their occurrence within mushrooms is extremely suggestive of at least another potential pest of cultivated mushrooms and as such it must be considered. Further, the occurrence of the larvae of other related species within manure is now a matter of some possible importance, and consequently all species thus recorded must be suspect.

At present, data on the biology of these Sphaerocerids is incomplete, but pairs of *L. heteroneura* were obtained without difficulty and attempts are being made to rear them in the manner recorded by Austin and Pitcher (1936). Eggs have been obtained—the flies oviposit readily on stable manure both sterile and unsterile—and larvae have been produced and pupae are now under observation.

Detailed information with reference to the British species of SPHAEROCERIDAE is available in a paper by Dr. Richards (1930) to whom I am indebted for his unfailing help. He mentions *L. heteroneura* as being taken in decaying vegetable matter during the summer, and records it as being found in mole's nests and a cormorant's nest, and also as being bred from damaged narcissus bulbs and decayed green ginger. Richards states that it is common in late summer and autumn (my records also show this) and that during the autumn and spring it is found mainly indoors. Records are given listing Lancs, Cheshire, Salop, Notts, Norfolk, Suffolk, Cambs, Oxon, Herts, London and Dorset as counties in which this species has been found.

Richards records ♀♀ as being present in all months except May and June and ♂♂ for all months.

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SOME NOTES REGARDING THE MORPHOLOGICAL AND BIOLOGICAL DIFFERENTIATION OF *CULEX PIPIENS* LINNAEUS AND *CULEX MOLESTUS* FORSKÅL (DIPTERA, CULICIDAE)

By J. F. Marshall, M.A., F.R.E.S., and J. Staley, F.R.E.S.

Of the mosquitoes of Europe, *Culex pipiens*—owing both to its almost universal distribution and to its domestic habits—is undoubtedly best known to the general public. In view of this fact it has been found difficult to understand why statements made by different investigators concerning the "nuisance-producing" capabilities of this mosquito exhibit great diversity of opinion.

In Britain, for example, widespread observation has led to the conclusion that *C. pipiens* rarely, if ever, bites human beings; while laboratory research has shown that this species obtains its blood-meals chiefly from birds. On the other hand, however, well-authenticated cases are occasionally recorded in this country of buildings being invaded by bloodthirsty, man-biting mosquitoes which have been subsequently identified as females of *C. pipiens* (Shute, 1933).

Not only in Britain but in many other parts of Europe this particular problem has received attention. So long ago as 1890, Ficalbi put forward the theory that the discordance of opinion was due to the existence of a species of *Culex* which had been hitherto undetected owing to its close structural resemblance to *C. pipiens*. Ficalbi named this new species *Culex phytophagus*; stating that it differed from the "common bloodsucking mosquito *Culex pipiens*" by subsisting wholly upon a vegetarian diet.

Ficalbi's summary of the adult characteristics distinguishing these two species from one another is given below.* This summary is inserted here for the sake of narrational continuity, but its detailed consideration must be postponed until later.

"The mosquito with which *Culex phytophagus* can be and is commonly confused (and it has not been described because it is so common), is the common blood-sucking mosquito which I have called *Culex pipiens*.† I give, therefore, some characters which may help in the differentiation of *Culex phytophagus* and *C. pipiens*. The general aspect of the two mosquitoes differs as follows: while our common blood-sucking mosquito has in general a pale colour, *C. phytophagus* is, as a whole, darker. Regarding certain details I consider: the dorsum of the thorax of *C. pipiens* appears light reddish, almost rust coloured, with golden tomentum, while in *C. phytophagus* the thorax is dark brown, with golden tomentum. The dark bands of the abdomen in *C. phytophagus* are almost black, while in *C. pipiens* they are of a chestnut brown, always a little lighter. The wings, to the naked eye, appear lighter in *C. pipiens*, more smoky in *C. phytophagus*. The legs give differential characters which are readily seen: the femora of *C. pipiens* are almost wholly pale yellow above and below, and only towards the distal extremity darkened a little, and at the level of the knees they present a lighter area which is scarcely noticeable: on the other hand, in *C. phytophagus* the femora are almost black above, and the yellowish spot on all the knees is evident to the naked eye: in *C. pipiens* the tibiae and tarsi are darker than the femora, but not black, while in *Culex phytophagus* the tibiae and tarsi are blackish-brown, and at the extremity of the tibia a yellowish-white spot is visible to the naked eye. It may be added that *C. pipiens* is notoriously a blood-sucker while *C. phytophagus* feeds on vegetable juices only."

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* The authors are indebted to Dr. F. W. Edwards for this translation of Ficalbi's summary, as well as for many valuable suggestions in regard to this paper.

† Ficalbi had some doubt as to whether his "common blood-sucking mosquito" was actually Linnaeus' *C. pipiens*: consequently he subsequently (1893) suggested the alternative specific name *haematophagus* for the Italian blood-sucking *Culex*. As will be seen later, the names *pipiens* and *phytophagus* in Ficalbi's summary must be replaced by *molestus* and *pipiens* respectively.

Ficalbi's "man-ignoring Culex" theory does not appear to have aroused much scientific interest, in spite of the fact that it received subsequent support from the observations of other workers. Grassi, for instance, stated (1923) that in districts where *C. pipiens* was a source of annoyance the adults were lighter in colour than those in districts where human beings were unattacked. Legendre, moreover, stated (1931) that he had observed, in the same locality in France, (*a*) a man-biting race of *C. pipiens* breeding in flooded cellars, rain-water cisterns and cesspools, and (*b*) a man-ignoring race of *C. pipiens* breeding in open waters. He also stated (1932) that the man-biting females had a light-coloured thorax, and the man-ignoring females a dark one.

In the year 1929, Roubaud (1929, 1930), de Boissezon and Huff independently announced that strains of *C. pipiens* existed which behaved in an abnormal manner notably in being able to mate in small cages and to lay fertile eggs without having a preliminary meal of blood. Roubaud assumed these biological peculiarities to be typical of a distinct race of *C. pipiens*. He subsequently (1933) introduced the adjective "autogenous" to distinguish the "bloodless-egg" race: the ordinary (blood egg) race thus becoming *Culex pipiens pipiens*, and the autogenous one *Culex pipiens autogenicus*.

Roubaud also coined the adjectives "stenogamous" and "eurygamous" to designate, respectively, mosquitoes which are able to mate in small cages and those which are unable to do so.

During the past five years or so, strains of "autogenous *C. pipiens*" imported into England from Germany have been investigated by MacGregor (1932), and strains imported from Greece, Malta and Hungary by Tate and Vincent (1933).

In October, 1934, a *Culex* egg-raft collected from a tank outside our laboratory at Hayling Island was transferred to a small incubator, in which larvae and adults subsequently developed. Although the adults were fed exclusively on raisins, two egg rafts were eventually found in the incubator, thus indicating that a British autogenous mosquito had been located (Marshall and Staley, 1935). Throughout the past two years the strain in question has been maintained in our laboratory: the adults being fed (as at first) exclusively on raisins, and the larvae on paste made from wholemeal bread.

Our preliminary investigations of this autogenous strain showed that it differed from the ordinary ("anautogenous") *C. pipiens* in (*a*) the lighter colour of the thorax of the adults; (*b*) the greater average number of hairs on the ninth tergite of the adults; (*c*) the relative shortness of the male palps in comparison with the proboscis; (*d*) the larger average number of branches in each of the four siphonal tufts of the 4th-instar larva; (*e*) the lower siphonal index of the 4th-instar larva; and (*f*) the greater width of the egg relatively to its length.*

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* This means of distinguishing the eggs of a British anautogenous strain from those of a *continental* autogenous strain had previously been utilised by Dr. Tate.

In an account of these investigations, we (1935) directed attention to the fact that our Hayling autogenous females resembled those of the strains described both by Roubaud and by Vincent in readily attacking human beings. We suggested that autogenous females were probably responsible for the occasionally-recorded "man-biting" invasions of buildings, for which the ordinary *C. pipiens* had hitherto been blamed. Evidence in support of this suggestion was subsequently provided by the infestation, by man-biting *Culex* females, of (*a*) a block of flats in Westminster and (*b*) a row of cottages in Hull. Both from a blood-filled female (caught in a bedroom) in the first case, and from larvae collected near the infested buildings in the second case, an autogenous strain has been established and is being maintained in our laboratory.

We have now maintained, through a large number of generations, autogenous strains derived from Hayling, Westminster, Hull, France and Greece, and we have also had an opportunity of examining larval and adult specimens of Hungarian and Maltese strains.

As the result of examining this additional material, we have to modify in some respects the conclusions stated in *Parasitology* (1935), which have been quoted on a previous page. We find that all the seven strains above specified resemble one another, but differ from the anautogenous *C. pipiens* in accordance with the following table :—

TABLE 1.

Larval and Adult Characteristics differentiating "anautogenous-eurygamous" from "autogenous-stenogamous" *Culex*.

	Anautogenous-eurygamous.	Autogenous-stenogamous.
LARVA.	(1) Average value of siphonal index about 5·0.	(1) Average value of siphonal index not exceeding 4·3.
ADULT (both sexes).	(2) General colouration darker brown than in autogenous. (3) Whitish scales at tips of femora and tibiae forming conspicuous spots.	(2) General colouration lighter brown than in anautogenous. (3) Pale spots at tips of femora and tibiae not conspicuous.
ADULT (male).	(4) Combined length of first four palp-segments exceeds overall length of proboscis.	(4) Combined length of first four palp-segments does not exceed overall length of proboscis.
ADULT (female).	(5) Pale tergal bands (at least on segment IV) constricted laterally and often also centrally; apical margins being consequently convex or bilobed. (6) Sternites having conspicuous median and lateral patches of dark scales.	(5) Pale tergal bands not constricted; basal and apical margins being consequently straight and parallel. (6) Sternites entirely light coloured or (in Hull and Westminster strains only) having inconspicuous median patches of dark scales.

The seven strains, however, differ noticeably from one another in regard both to the average number of branches in the siphonal tufts of the 4th-instar larvae, and to the average number of hairs per lobe on the ninth tergite of the male and female adults. In the Hungarian strain, for instance, the "tuft-branch" counts are low, and the "tergite-hair" counts high; in the Hayling strain both counts are high; and in the Westminster strain they are both low. In the Greek strain (which we maintained through 10 generations) a large proportion of the larvae had three pairs of siphonal tufts instead of the usual four.

Numerical data exemplifying the above statements are brought together in Table 2, and are shown diagrammatically in the form of "chaetographs" (figs. 1 and 2). In Table 2 (the columns of which are lettered to correspond with the diagrams) the average value of the siphonal index is given in column A; the average numbers of branches in the siphonal tufts, in columns B, C, D, E; and the average number of hairs per lobe of the 9th tergite, in the female and in the male, in columns F and M respectively.* In the chaetographic diagrams, for the sake of compactness, the "tergite-count" values are halved before plotting.

TABLE 2.

Larval and hypopygial chaetotaxy of *Culex pipiens* and varieties of *Culex molestus*.

Place of Origin of Strain.	Reference Number of Strain.	Generation (reckoned from Time of Receipt of Material).	Aver. Value of Siphonal Index. A.	Average Number of Branches in Siphonal Tufts.				Average Number of Hairs per Lobe of Ninth Tergite.	
				B. (Tuft I).	C. (Tuft II).	D. (Tuft III).	E. (Tuft IV).	F. (Female).	M. (Male).
			Av.*	Av.*	Av.*	Av.*	Av.*	Av.*	Av.*
Culex pipiens Linnaeus.									
ENGLAND: Hayling Island	7961, &c.	Locally collected material.	5·0 (432)	2·5 (760)	2·5 (559)	2·3 (724)	2·6 (746)	8·8 (158)	8·2 (150)
,, Cambridge	7889	Preserved material.	4·8 (104)	2·5 (125)	2·3 (125)	2·2 (110)	2·5 (132)	8·8 (80)	8·2 (151)
Culex molestus Forskål.									
ENGLAND: Hayling Island	7780	2nd.	4·0 (155)	3·9 (102)	3·9 (101)	3·2 (102)	3·2 (100)	12·9 (78)	13·3 [illegible]
,, ,, ,,	7780	10th.	3·8 (110)	3·8 (192)	3·6 (201)	2·9 (184)	3·0 (205)	11·4 (143)	12·0 (85)
,, ,, ,,	7780	24th.	3·8 (20)	4·1 (38)	4·0 (36)	3·1 (29)	2·9 (24)	11·8 (36)	11·8 (45)
,, Hull	7947	2nd.	4·2 (74)	3·5 (125)	3·8 (122)	3·1 (119)	3·4 (124)	16·0 (22)	14·7 (28)
,, ,,	7947	14th.	4·3 (57)	3·9 (73)	3·5 (70)	3·0 (69)	3·0 (69)	14·7 (65)	13·3 (83)
,, Westminster	7932	1st.	4·0 (50)	3·0 (98)	2·9 (97)	2·4 (84)	2·7 (96)	7·6 (14)	7·2 (12)
,, ,,	7932	2nd.	3·8 (170)	2·9 (284)	2·9 (286)	2·2 (277)	2·9 (300)	7·8 (101)	6·8 (92)
FRANCE	7915	1st.	4·3 (112)	3·5 (174)	3·4 (178)	3·0 (140)	2·9 (162)	14·2 (103)	11·1 (122)
GREECE	7890	2nd.	3·9 (119)	3·4 (128)	3·2 (132)	2·8 (130)	3·1 (131)	10·1 (90)	10·2 (148)
,,	7890	6th.	3·9 (53)	3·6 (24)	3·0 (30)	2·7 (34)	2·8 (32)	9·7 (30)	9·5 (12)
HUNGARY	7927	Preserved material.	3·9 (25)	2·5 (33)	2·6 (34)	2·2 (32)	2·2 (31)	13·6 (158)	11·0 (44)
MALTA	7928	Preserved material.	3·8 (100)	3·0 (112)	2·7 (101)	2·4 (97)	2·5 (113)	10·9 (58)	10·2 (39)

* The figures between brackets represent the number of cases.

The compilation of the chaetotaxic and other data concerned has been rendered possible only by the kindness of Prof. Roubaud, of Paris, and of Dr. Tate and Miss Vincent, of the Molteno Institute, Cambridge. We are indebted to Prof. Roubaud for autogenous egg-rafts from France, and to the Cambridge investigators both for autogenous egg-rafts originating from Greece and for preserved larval and adult specimens originating from Hungary and Malta. From the Greek egg-rafts we reared 10 autogenous generations; and we are still maintaining, in our laboratory, the French and the three English strains. The sources from which the three English strains were derived have been already specified.

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* To facilitate subsequent reference, the autogenous *Culex* appears in Table 2 under the name of *Culex molestus*, in anticipation of conclusions stated later in the context (p. 23).

In Table 2, the numerical data relating to different varieties of the autogenous *Culex* are preceded by corresponding information relating to the anautogenous *Culex pipiens.* The numbers occupying the uppermost horizontal line were obtained by examining specimens derived from egg-rafts collected at Hayling Island: and those occupying the second line by examining preserved specimens of a strain of *Culex pipiens* maintained (by breeding in a large cage) at the Molteno Institute, Cambridge. The chaetotaxic characteristics which distinguish these anautogenous strains of *C. pipiens* from the autogenous *Culex* (Hayling Island variety) are contrasted in fig. 1.

In all the six diagrams of fig. 2, the chaetograph corresponding to the uppermost line of Table 2 (Hayling Island anautogenous *C. pipiens*) is included for purpose of comparison.

In a letter to *Nature*, dated October 8, 1935, we gave a brief summary of the results of our investigations up to that time. This letter concluded with the following paragraph:—

"It appears, therefore, that Roubaud's original (French) *C. pipiens autogenicus* is but one of a number of autogenous strains, all of which differ very markedly from the anautogenous *C. pipiens*, and also—to a lesser but quite obvious extent—from one another. In view of this fact we submit the suggestion that some specific name other than *pipiens* should be adopted to designate both the present and later-discovered members of this autogenous, short-siphoned, short-palped group: varietal names (preferably of geographic import) being appended whenever the recognition of definite morphological or biological differences renders such action desirable. In favour of reviving the specific name *domesticus*, Germar, for this purpose there is a great deal to be said."

Subsequently to the appearance of the above letter, Tate and Vincent published the results of experiments (1936) in which, *inter alia*, Greek autogenous (stenogamous) males mated in a *small* cage with British anautogenous (eurygamous) females and formed the basis of a strain which was maintained through ten generations. In the course of the first three generations, 197 females were raised, and only 6 autogenous egg-rafts were obtained; but in the fourth generation the proportion of egg-laying females suddenly increased to 68 per cent., while in subsequent generations it varied from 54 to 67 per cent. No morphological comparisons, however, appear to have been made in any of the generations, and it seems possible that, during the first three generations, the anautogenous and eurygamous characters were being segregated out in accordance with Mendel's second law. In any case we remain in favour of regarding the "anautogenous-eurygamous" *Culex* and the "autogenous-stenogamous" one as distinct species; not only because of the conspicuous larval and adult characteristics differentiating the two mosquitoes in question, but also because of the convenience of being able to apply the adjective "varietal" to the lesser (though in most cases quite obvious) points of distinction which enable autogenous strains (whether Continental or British) to be separated from one another.

It may be mentioned that, in cross-mating experiments carried out (at Hayling Island) on autogenous strains derived from France, Hayling, Hull and Westminster, mating took place in all cases: viable eggs being obtained when Hayling males mated with females of any of the other three strains, but not in the converse crosses. Viable eggs were obtained by crossing both ways only in cases where the French and Hull strains were associated.

The existence in Britain of a light-coloured, man-biting *Culex*, which is distinguishable from the dark-coloured, man ignoring *C. pipiens*, falls into line with the observations of Grassi, in Italy, and of Legendre, in France, to which reference has already been made. Moreover, the respective adult characteristics of these two mosquitoes are practically identical with those described by Ficalbi.

In our opinion, the information acquired, during the past few years, regarding autogenous and anautogenous strains of *Culex* fully establishes the validity of the theory advanced by Ficalbi—that two distinct species have been confused under the name *pipiens*. If this be admitted, we have then to decide

(*a*) which of the two species is entitled to the specific name of *pipiens*; and
(*b*) what specific name is to be adopted for the other one.

In regard to the first of these questions, it must first of all be noted that in 1737 (that is to say, 21 years previous to the arbitrarily established starting-point for zoological nomenclature) Linnaeus bestowed the name *Culex alpinus* on the common mosquito of Lapland—a mosquito, to judge by its place of occurrence, which was almost certainly a species of *Aëdes*. In the tenth edition of the *Systema Naturae*, published in 1758, Linnaeus referred to this mosquito as *Culex pipiens*, and gave references to descriptions and illustrations by Réaumur and others; but in 1761 he revived his earlier name *alpinus*. As pointed out by Dyar and Knab (1909), the name *pipiens* became thereby restricted to the insects described by the authors quoted by Linnaeus. Linnaeus, for instance, referred to plates 43–44 in the fourth volume of Réaumur's *Histoire des Insectes*, published in 1738. Figures 2–8 of pl. 44 illustrate egg-rafts and detached eggs, the latter having the terminal "corolla" typical of the genus *Culex*. Figures 2–3 of pl. 43 show full-grown larvae: the siphon in each figure having the multiple hair tufts diagnostic of *Culex* and the slender proportions characteristic of anautogenous strains. Plate 40 of the same volume is of special importance. Figure 3 of this plate shows the terminal segments of a male palp of the *Culex* type, and figures 6 and 10 show the venter of a female and male adult respectively. In each of the last-mentioned figures the sternites are ornamented with conspicuous, dark, median patches which are characteristic of anautogenous strains. This fact appears clearly to indicate that the name *Culex pipiens* belongs to the man-ignoring, dark-coloured, ventrally-spotted species and not (as Ficalbi considered) to the man-biting, light-coloured, ventrally-unspotted one.

The question of providing a specific name for the man-biting, autogenous species must next be considered.

Among the numerous supposed synonyms for *C. pipiens* there are at least three which, in the author's description of the species, make reference to biting propensities. One of these supposed synonyms—namely *C. haematophagus* Ficalbi (1893)—has already been discussed. The other two supposed synonyms—namely *C. molestus* Forskål (1775) and *C. domesticus* Germar (1817)—were bestowed upon night-biting species of *Culex* prevalent in the Nile Delta and Dalmatia respectively.

In describing the habits of *C. molestus*, Forskål refers to its night-biting capabilities. "Rosettae, Kahirae et Alexandriae immensa copia, nocte incommodus dormientibus et vix arcendus nisi cortina bene clausa." In describing the adult he refers to ". . . rostro cinereo, apice nigro, crassiusculo; dorso fusco, fasciis sex pallidis." These statements clearly refer to a species of *Culex*, and not to one of *Aëdes*.

Germar's description of *C. domesticus* obviously refers to a *Culex* which (in Dalmatia) is abundant in houses, bites only at night, and is more bloodthirsty than "the common mosquito."

If one may assume that both Forskål and Germar were concerned with the autogenous *Culex*, Forskål's specific name *molestus* appears to be preferable to either *domesticus* or *haematophagus* on account of priority. In the south-eastern Mediterranean, moreover, both the darker, ventrally-spotted *C. pipiens* and its lighter, ventrally-unspotted associate are known to occur—specimens, from Egypt, of both these mosquitoes being in the British Museum collection. Further evidence of the fact that both *C. pipiens* and "*C. molestus*" occur in Egypt is provided by certain references to "*Culex pipiens*," in Kirkpatrick's *Mosquitoes of Egypt* (1925), which are quoted below :—

(*A*).. REFERENCES INDICATING THE PRESENCE IN EGYPT OF *C. PIPIENS*.

(1) pp. 133, 134 (in regard to ♂) :—" Palpi longer than the proboscis by the length of the last joint and half the penultimate joint."

(2) fig. 112 of pl. XXI. Illustration showing a larval siphon with an index of about 5·2, and a tuft-count of 3–4–4–3.

(*B*). REFERENCES INDICATING THE PRESENCE IN EGYPT OF *C. MOLESTUS*.

(3) p. 134 (in regard to ♂ hypopygium) :—" The lobes of the ninth tergite each with about twelve rather long fine bristles."

(4) p. 135 (in regard to 4th-stage larva) :—" Siphonal tufts . . . each composed of four to seven hairs. . . ."

(5) p. 144 (in regard to times of activity) :—" *Culex pipiens* frequently bites ones ankles. . . ."

(6) p. 146 (in regard to mating) :—" My assistant induced *C. pipiens*, a species which undoubtedly often forms nuptial swarms, to copulate and lay fertile eggs in a cage not more than 10 by 6 by 6 inches."

(*C*). REFERENCES INDICATING THE PRESENCE IN EGYPT OF BOTH *C. PIPIENS* AND *C. MOLESTUS*.

(7) p. 136 (in regard to 4th-stage larva) :—" Siphon very variable in length, usually about 4·5 times as long as broad at the base, but varying from not much over 4 to about 5·2."

(8) p. 143 (in regard to food and feeding habits) :—". . . my assistant has observed *C. pipiens* (but only one individual out of a considerable number) to lay fertile eggs when the only food available had been the juice of green plants."

CONCLUSIONS.

1. Investigations carried on during the past few years regarding "autogeny" in *Culex pipiens* have incidentally confirmed the suggestion, made by Ficalbi (1890), that two distinct species—one a man-biter and the other a man-ignorer—have been confused under the name *Culex pipiens*.

2. The name *Culex pipiens* Linnaeus should be reserved for the man-ignoring species.

3. The name *Culex molestus* Forskål should be revived for the man-biting species.

4. At least seven distinguishable " varieties " of *C. molestus* are at present known.

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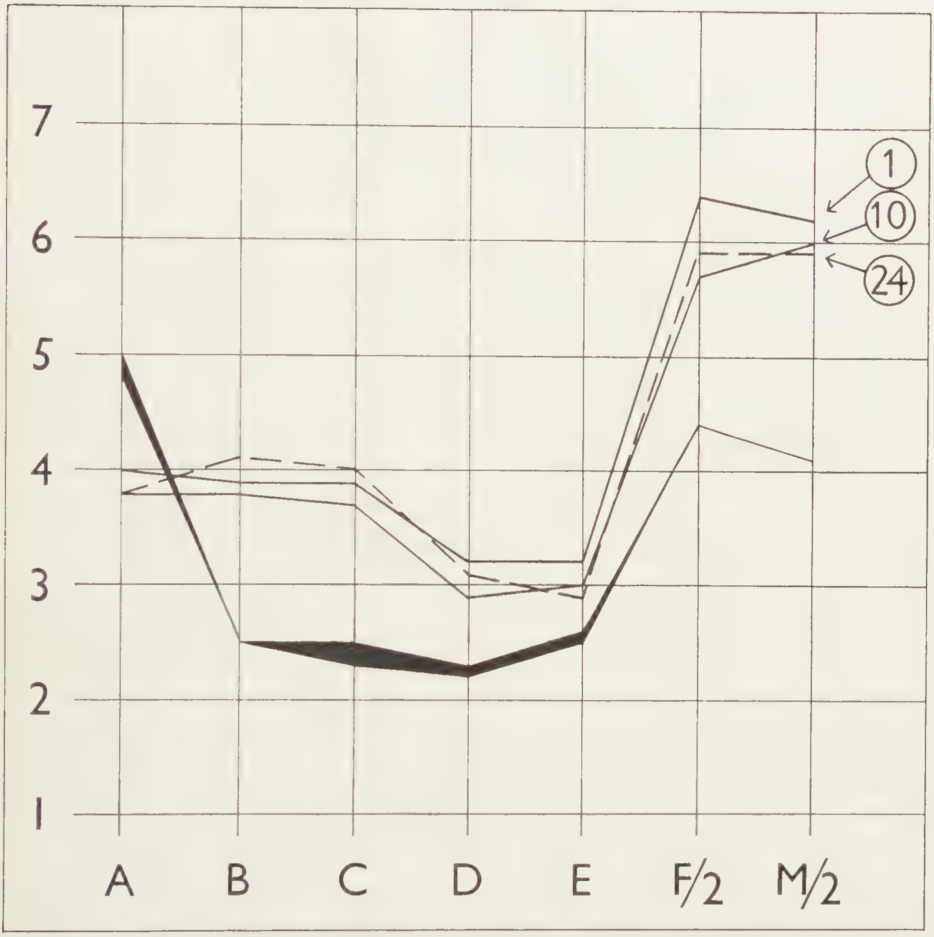

FIG. 1.—Chaetographic representation of morphological characteristics differentiating anautogenous and autogenous strains of *Culex*.

The narrow, irregular area shown in black is the space enclosed between two chaetographs of the anautogenous *C. pipiens*—the upper and lower graphs representing data derived from Hayling Island and Cambridge respectively. The three separate chaetographs lying above the black area are those of three different generations of the autogenous *Culex* (Hayling variety). The numbers in circles indicate the number of generations reared in the laboratory.

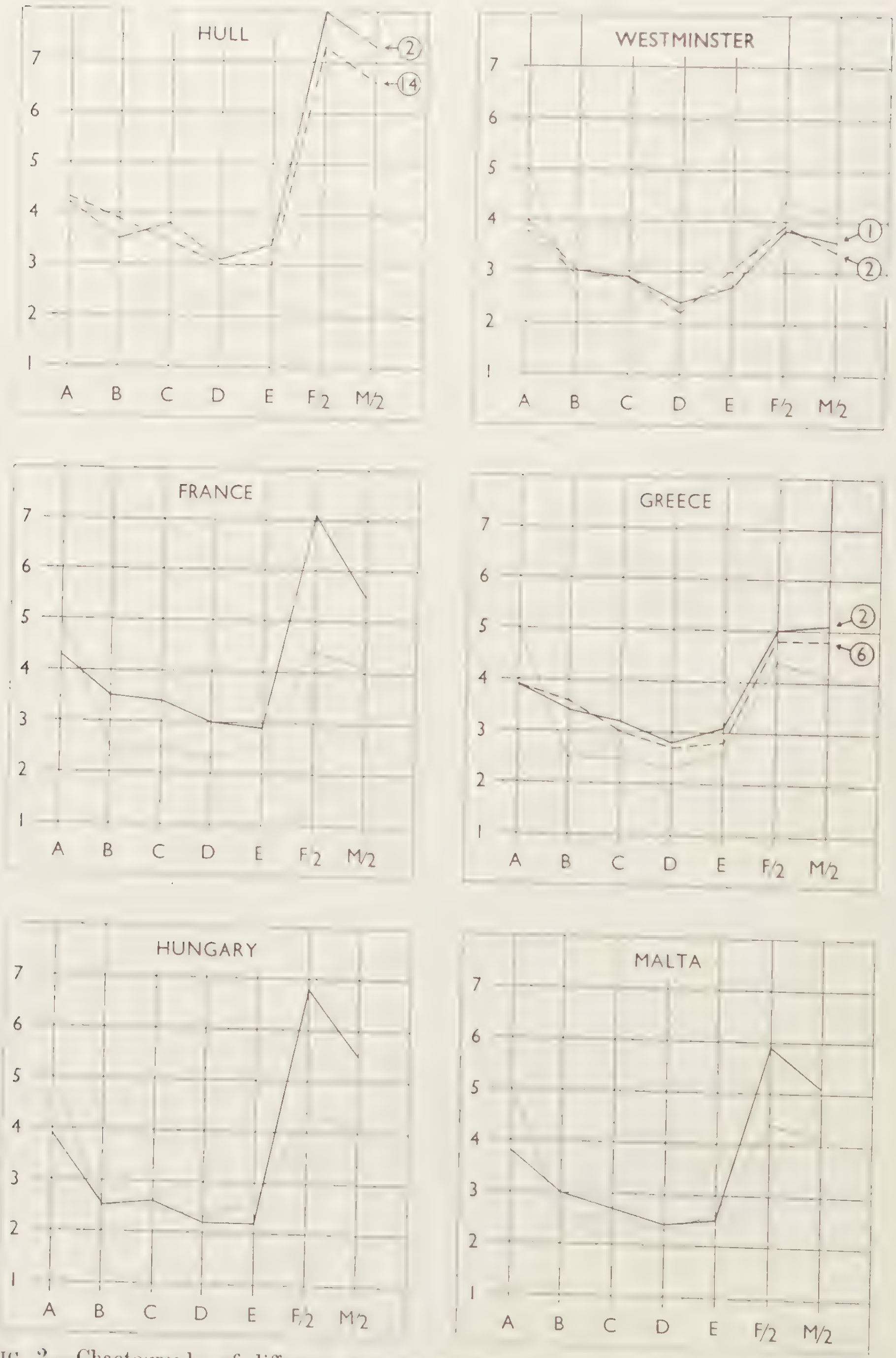

Fig. 2.—Chaetographs of different varieties of the autogenous *Culex* compared with a chaetograph of the anautogenous *C. pipiens* (thin line). The numbers in circles indicate the number of generations reared in the laboratory.

THE MATING-HABITS OF SPECIES OF *VESPA* (HYMEN.)

By Dr. O. W. Richards, F.R.E.S.

Prof. Sir Edward Poulton, F.R.S., recently made some interesting observations on the mating-habits of *Vespa germanica* Fab. When he came to inquire what was known on this subject, I found that my ideas were rather hazy and I have therefore been prompted to put together these notes.

Sir Edward has kindly written the following account of his observations: "13th October 1935. A pair of one of the 'Common Wasps,' afterwards found to be *V. germanica* Fab., was observed *in coitu* about 11.45 a.m., on the pavement of Banbury Rd., Oxford. As this was the first time that I had seen a living pair of any wasp in the genus, I was anxious to capture them and observe the behaviour of both sexes. Disturbed by my attempts, the pair, drawn by the fluttering wings of the female, moved fairly rapidly along the pavement but was unable to rise. Two or three times I managed to induce them to enter my hat, but the female, dragging the male, instantly climbed to the brim and flew, taking off at a height of two or three feet from the pavement. She was, however, quite unable to maintain this level and gradually sank until the ground was reached after a flight of several yards. The last of these attempts to escape ended in the road with its constant stream of motor traffic. This was a risk which I felt must not be repeated and accordingly pressed the hat against my body as soon as the wasps had entered it. Thus safely enclosed they were easily taken to my house which was near at hand, carried to the laboratory and transferred to a glass-bottomed box, 1¾ in. in diameter. It was evident that *coitus* at this stage is not to be ended by repeated and very considerable disturbance. Within the box the female at once began a series of attempts to induce the male to withdraw. Her behaviour was characteristic. She assumed a position which enabled her to mount the back of the male and seize with her widely opened mandibles the dorsal surface of an anterior abdominal segment. 'Seize' is an incorrect term, for the polished exoskeleton did not admit of seizure, but the closing mandibles would certainly cause a tactile stimulus. The female then withdrew to a slightly more posterior position where her mandibles again embraced and closed at the mid-dorsal line of the male's abdomen. Repeating this process many times and rapidly, the mandibles reached and worked upon the male intromittent organ. The armature was never visible. The impression was again that of tactile stimulus and not of attempt to sever or in any way injure the organ, but it is hoped that a microscopic examination will decide. The mandibles at this point opened and closed many times (unlike the single movement at each withdrawal posteriorly), but finally desisted when the efforts were fruitless. The whole process I have described occupied but a few seconds and I saw it repeated several times during the brief period of captivity in the box. In every instance the female mandibles embraced the dorsal surface of an anterior abdominal segment and reached the male organ after a series of backward movements and embracings. Finally about 12.12 p.m., less than half an hour after the capture, the male withdrew at the close of an attempt which appeared to be precisely similar to others made by the female. I gained the impression that the male's behaviour was a voluntary response to tactile stimulus.

"The insects were then placed in a large transparent glass lamp-shade standing on earth and with the upper, larger end covered with a coarse gauze. A few pieces of stick afforded foothold and were always sought for resting. The wasps were first offered food—pieces of apple and over-ripe plum sprinkled with powdered sugar, also sugar and water—at 2.0 p.m. 15th Oct., and both at once began to feed. On the morning of 16th Oct. a little bacon fat and a piece of meat from the leg of a fowl were added. The male was always more easily stirred into activity and flight by the warmth and light of the sun, than the female, but both were seen to be drinking the sugar and water on 21st Oct. On 24th Oct. I left the wasps at the Linnean Society in London, where Dr. O. W. Richards obtained them on the following day."

The male wasp when in my (O.W.R.) care died on 26th Oct.; on 28th Oct., I killed and dissected the female, which was still alive and evidently just assuming the hibernation attitude, and found that her spermatheca was full of sperm. The male genitalia had been normally retracted into his abdomen and there was no indication that any damage had resulted from the malaxation by the female.

The two common species of social wasp (*V. vulgaris* L. and *V. germanica* Fab.) differ from the other British species in producing males very late in the season, whereas males of *V. rufa* Fab., *V. sylvestris* Scop. and *V. norwegica* Fab. appear in Aug.–Sept. Mr. G. E. J. Nixon tells me that males of the first two species normally appear out of doors in October, but they may appear in the nests two or three weeks earlier. In exceptional nests, in which the queen has died and the workers have laid parthenogenetic eggs, males may appear earlier still; but this is clearly abnormal and perhaps uncommon. I have collected together all the records of date of capture of males of the two species from specimens in my collection and in those of the Natural History Museum and Hope Dept.

V. germanica Fab. 1, FRANCE: Avallon, Yonne, 13.viii.23 (*O.W.R.*); British localities—3, 19.ix., 1, 29.ix., 4, 3.x., 1, 7.x., 1, 12.x., 1, 14.x., 2, 21.x., 5 "Sept.," 11 "Oct."; two nests excavated at Slough, Bucks (*O.W.R.*), one, 11.ix.35, still contained no males; one, 10.xi.33, also contained no males (*i.e.* they had all left the nest).

V. vulgaris L. 4, Faversham district, Kent, 4.viii.01 (*A. J. Chitty*, Hope Dept.); 1, 28.ix., 1, 2.x., 1, 14.x., 1, 15.x., 1, 16.x., 1, 3.xi., 10 "Sept.," 13 "Oct."; a nest excavated at Slough, Bucks, 17.ix.31 (*O.W.R.*) contained many males.

The male of *V. germanica* from Avallon and the four males of *V. vulgaris* from Faversham captured in August, may be abnormal males of the type already alluded to. A male found dead on Hampstead Heath, 10 Oct., had apparently only just died and had the genitalia strongly exserted, almost torn out. It was thought at the time that this was due to difficulty in disengaging after copulation; but it is evident from the data recorded below that if the condition of the genitalia was indeed due to this cause, the example is exceptional.

Observations of either of the above two species actually *in copula* have not often been made. In the Hope Department collection, there are two pairs of *Vespa germanica* captured *in cop.* (ix.21 and ix.22, *T. Trollope*), but there are no observations accompanying the specimens. The most complete record is due to Marchal (1896, *Arch. Zool. expér. gén.*, (3) **4**: 44), who observed the pairing of several species in captivity. He says:—"J'ai assisté, dans mes cages d'expérience, un très grand nombre de fois a l'accouplement de Guêpes appartenant aux espèces *Vespa germanica, V. vulgaris* et *V. saxonica.* Cet accouplement se passait à terre et durait quelques minutes; lorsque la femelle jugeait que l'acte était terminé, elle se renversait sur le dos du mâle et le mordait à l'abdomen pour lui faire lâcher prise. Ce fait, déjà signalé par Rouget pour les Frelons, est assez constant."

Later he adds that *V. vulgaris* and *V. germanica* mate in October, while Rouget found *V. crabro* L. to mate at the same period. *V. saxonica* (= *V. norwegica*), in cages, mates between 25th June and the end of July. In a cage, a fertilised female of *V. vulgaris* mated again without any hesitation; but this may not be usual in nature. Fertilised females of *V. saxonica* refused to mate again, though the males may mate more than once.

Rouget's observations on the hornet (*Vespa crabro* L.) are as follows (1873, *Mem. Acad. Sci. Arts Belles Lettres Dijon,* (3) **1** : 186–187) :—" J'ai observé, le 7 Octobre, plusieurs accouplements de la *V. crabro.* Les femelles s'étaient cramponnées à de petites branches d'arbustes et avaient recourbé leur abdomen presque à angle droit, de manière à faire le plus de saillie possible. Les mâles, guidés sans doute par leur odorat, passaient et repassaient près de ces femelles sans les découvrir. Enfin, après un temps assez long, le mâle finissait par trouver la femelle, mais comme fortuitement; les deux insectes s'unissaient; bientôt la femelle, entrainant le mâle, se laissait tomber avec lui sur le sol, ou l'accouplement se continuait encore pendant quelques minutes; la femelle relevait ensuite la partie antérieure de son corps et, se plaçant sur le mâle, pressait l'abdomen de celui-ci entre ses mandibules, comme si elle eût voulu indiquer que l'acte était accompli et provoquer une séparation, qui en effet avait lieu quelques instants après. La femelle s'envolait presque aussitôt, mais le mâle restait encore à terre pendant un certain temps avant de prendre son vol." He also notes that one male can mate with more than one female.

I have found two other accounts of mating in *Vespa,* one by Donisthorpe (1917, *Ent. Rec.,* **29** : 231–232) purporting to deal with *V. vulgaris* and one by Gascard (1926, *Bull. Soc. Amis Sci. nat. Rouen,* **60–61** (1924–1925) : 194–195) purporting to deal with *V. germanica.* Neither of these authors captured the pair they observed, so that the identification is necessarily somewhat dubious. Their observations do not add anything material to the accounts provided by Sir Edward Poulton and Prof. Marchal. Both, however, confirm the view that paired wasps are unable to rise from the ground in flight.

I am much indebted to Dr. B. M. Hobby for sending particulars of the specimens of *Vespa* in the Hope collection, and to Prof. Sir Edward Poulton for allowing me to put his interesting observations on record. Mr. G. E. J. Nixon was also able kindly to answer a number of questions from his wide experience of Vespine behaviour.

NEW AND RARE BEETLES FROM WINDSOR FOREST

By H. St. J. K. Donisthorpe, F.R.E.S.

In July of this year I collected a number of specimens of *Gastrallus laevigatus* Ol. in Windsor Forest. No species of this genus has been previously recorded from Britain, the known distribution being central and south Europe, Syria and Palestine. The specimens were taken chiefly resting on elm logs, a few being beaten from maple and others collected by sweeping.

Mr. A. Allen also took a specimen, and I took a specimen and a larva of *Adelocera querca* Herbst from an old oak tree in Windsor Forest. The only previous record of this species from Britain is that of Stephens in 1830, which records that the only specimen Stephens had seen was also taken in Windsor Forest by J. H. Griesbach.

Book Notices.

Sweetman, H. L., *The biological control of Insects. With a chapter on weed control.* pp. xii + 461, 1 pl., 142 figs. 8vo. Comstock Publishing Co., Ithaca, N.Y., 1936. Price $3.75.

The fourteen chapters of this book are devoted to a discussion of the theoretic basis of biological control; resistant plant hosts; the use of microscopic organisms, nematodes, parasitic and predatory insects and predatory vertebrates; the peculiar characteristics of parasites; the possibilities and methods of biological control. The results of past experiments is given.

It is intended as a general treatise for entomologists, a book of reference for the specialist and a text-book for the student.

Its appearance is welcome as it fills a noticeable gap in the literature of a subject which to-day is so much discussed. The book will also serve to answer many questions for the casual inquirer and the publicist. It claims to be right up to date.

Burr, M., *British Grasshoppers and their allies. A stimulus to their study.* pp. xvi + 162 + [2], 6 pls., 56 figs., 40 maps. 8vo. P. Allan & Co., Ltd., London, 1936. Price 6*s*. 0*d*.

As is stated in the preface the only existing books devoted to our Orthopterous fauna are those by Dr. Burr and the late Mr. Lucas. Over both of these this new book has great advantages in the matters of size and completeness. A special feature of the volume is its size $6\frac{3}{4} \times 4\frac{1}{2}$ inches, which is intended to make convenient its transport in the pocket. Another special feature is the 40 maps showing the known distribution of all the species and the enormous gaps in our knowledge.

It should be pointed out that Earwigs, Cockroaches and Crickets are included and that a supplementary page recording *Conocephalus fuscus* from the Isle of Wight brings the book right up to date.

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